EPA

Enforcement Facts and Strategy

Polychlorinated Biphenyls (PCBs)

Supporting Documents

Contents

Note on Supporting Documents

The materials in Sections II-V are extracted from a report prepared by Putnam, Hayes, and Bartlett under a contract with the Pesticides and Toxic Substances Enforcement Division. They discuss the methodology used in developing the statistical and analytical foundation for directing the inspection and awareness efforts in the PCB enforcement strategy.

The final strategy reflects the findings of the contractor study, with adjustments made to reflect the practical experience already gained by the Agency in implementing a PCB enforcement program.

The materials are offered here only to demonstrate the theoretical foundation of the strategy. Some of the report's conclusions have been rejected in the final strategy, and some matters addressed in the strategy were outside the scope of the contractor study.

I Allocation of Inspection Resources

Inspections of target groups have been scheduled based on both the estimated quantities of PCBs coming up for a disposal decision and the effectiveness of inspection activities in that target group.

Inspections were allocated to target groups in such a way as to maximize the total pounds of PCBs that receive proper disposal.

The method for determining the optimal inspection allocation is complex and is explained in detail in the supporting documents. The inspection allocation is shown below in percentage of total inspections for a given year on a national basis. The number of actual inspections will be determined through the annual budgeting process. Because the geographic distribution of facilities in the industry categories varies, a further refinement of the percentages may be needed on a Region-by-Region basis. This refinement will also take place during the budget process.

Table II-1

Allocated Inspections by Sector or Industry
(per year, shown in percentage of total number of inspections)

Sector/Industry	Percentage of Inspections
Railroads	20 %
Complaints, Crises, Special Situations	16 %
Metals	14 %
Chemicals	13 %
Utilities	12 %
Food and Feed	10 %
Paper and Lumber	10 %
Commercial Buildings	8 %
Stone, Clay, and Glass	5 %
Textiles	5 %
Mining	3 %
Automobile	1 %

Approximately 16 percent of the inspection resources has been reserved for response to complaints, crises, and special situations. If there is an unexpected higher or lower number of such situations, the percentages may be adjusted evenly across categories.

In addition, the inspections in each category should be performed at facilities owned by companies of varying sizes. When possible, approximately 50 percent of the inspections should be performed at facilities owned by companies in the top 20 in size; 25 percent in the next 30 in size; and 25 percent in the remaining companies. The following table shows estimates of the numbers of facilities nationally, arranged by size of company.

Estimated Number of Facilities Arranged by Size of Company

Sector/Industry	Facilities
UTILITIES	
Top 4 Companies	360
Next 4 Companies	216
Next 12 Companies	446
Next 30 Companies	571
Remaining Companies	943
TOTAL	2,536
AUTOMOBILE	
Top 4 Companies	58
Next 4 Companies	11
Remaining Companies	163
TOTAL	232
CHEMICALS	
Top 4 Companies	495
Next 4 Companies	258
Next 12 Companies	311
Next 30 Companies	466
Remaining Companies	1,401
TOTAL	2,469
FOOD	
Top 4 Companies	787
Next 4 Companies	393
Next 12 Companies	548
Next 30 Companies	759
Remaining Companies	11,562
TOTAL	14,049
METALS	
Top 4 Companies	398
Next 4 Companies	137
Next 12 Companies	277
Next 30 Companies	327
Remaining Companies	2,201
TOTAL	3,340
MINING	
Top 4 Companies	1,620
Next 4 Companies	660
Next 12 Companies	720
Next 30 Companies	3,000
Remaining Companies	--
TOTAL	6,000
PAPER AND LUMBER	
Top 4 Companies	452
Next 4 Companies	316
Next 12 Companies	509
Next 30 Companies	588
Remaining Companies	9,436
TOTAL	11,301
STONE, CLAY, AND GLASS	
Top 4 Companies	366
Next 4 Companies	169
Next 12 Companies	237
Next 30 Companies	316
Remaining Companies	1,404
TOTAL	2,492
TEXTILES	
Top 4 Companies	236
Next 4 Companies	149
Next 12 Companies	249
Next 30 Companies	419
Remaining Companies	2,054
TOTAL	3,107

Inspection Scheduling

The neutral administrative inspection scheme identifies the individual sectors to be inspected, and targets a proportion of inspections in each sector to companies of varying sizes. Although facilities selected for routine inspection should be part of a targeted segment, the Regions may apply other neutral criteria, such as geographic considerations, before making the random selections.

From time to time, a special, more intensive inspection effort may needed in a target or non-target group, such as in response to new information regarding potentially widespread contamination from a particular source. In such cases, PTSED wil provide sufficient information to the Regions about the target group and any special instructions required so that the special inspection program can be implemented.

The Agency also receives numerous tips and complaints regarding possible PCB violations. The priority given to responding to these situations is to be based on the severity of the environmental hazard posed by the condition, to the extent that it can be determined without on-site investigation. In some cases, an immediate inspection will be indicated. The response to less severe problems may range from contacting the facility by telephone or correspondence to scheduling of a compliance monitoring inspection as part of the Region's routine inspection plan.

When required, the percentages of resources allocated may be adjusted evenly across the target groups to meet unanticipated increases or decreases in the number of inspections needed for special situations.

The materials on the following pages are extracted from:

TSCA/PCB ENFORCEMENT STRATEGY

Prepared by

Putnam, Hayes and Bartlett, Inc.
Boston, Massachusetts
December, 1979

Under a contract with

Pesticides and Toxic Substances Enforcement Division
Office of Enforcement
U.S. Environmental Protection Agency

The majority of the PCB's currently in service are contained in transformers and large capacitors installed between the years 1945 and 1975.[1] While small quantities of PCB's are in service in other uses, the disposal of these PCB's is not regulated due to their small quantities and/or low concentrations. The enforcement strategy must, therefore, concentrate on the proper disposal of PCB's in transformers and large capacitors.[2]

In order to develop an enforcement strategy that insures the proper disposal of PCB's contained in transformers and capacitors, EPA must know where the transformers and capacitors are located and when PCB's contained in the equipment will require a disposal decision. Since EPA does not have detailed information in these areas, it was necessary to estimate where this equipment is likely to be located and when it will be removed from service. PHB has developed such projections for 47 target groups.

For the purposes of this analysis, a target group is defined as a subsegment of industrial firms, utilities, railroads or commercial buildings. Exhibit II-1 illustrates the target groups used by PHB. As shown in Exhibit II-1, each industry in the industrial sector and the utility sector is divided into five target groups based on size of firm. The commercial and railroad sectors are each treated as a single target group.

---

[1]After 1975, Monsanto, the primary manufacturer of PCB's, ceased production of these compounds.

[2]Small capacitors may be disposed of as municipal solid waste and hence, are not considered in the enforcement strategy. All further reference to capacitors in this report refers to large high and low voltage capacitors.

The remainder of this chapter presents:

- PHB estimates of the number of PCB transformers and capacitors by target group in service in 1979,
- PHB estimates of the pounds of PCB's requiring disposal decisions each year by sector, and
- the methodology used by PHB to derive these estimates.

TRANSFORMERS AND CAPACITORS BY TARGET GROUP

For each target group, the number of PCB transformers and capacitors in service in 1979 is presented in Exhibits II-2 and II-3, respectively. As can be seen in these exhibits, 31 percent of all PCB transformers and 45 percent of all capacitors in service in 1979 are owned by utilities. Other major users of PCB equipment include the entire industrial sector and commercial buildings. Within the industrial sector, the majority of PCB equipment is owned by the metals, chemicals, and paper and lumber industries.

For some industries, the ownership of PCB equipment is highly concentrated. For example, it is estimated that 93 percent of all of the PCB transformers and capacitors in the automobile industry are owned by the four largest firms in the industry. However, for some industries, such as food, a much smaller portion of the industry's PCB equipment is concentrated in the four largest firms.

Since EPA's enforcement strategy must impact decisions made at the plant level, it is also useful to project the number of transformers and capacitors per plant in each target group.

These estimates are presented in Exhibits II-4 and II-5. As is illustrated in these figures, the number of transformers per plant ranges from 0.1 to 39.9 for the different target groups.[1] The number of capacitors per plant ranges from 1.6 to 673.5.

REQUIRED DISPOSAL DECISIONS BY YEAR

Exhibit II-6 presents estimates of the number of pounds of PCB's requiring disposal decisions each year for each sector. These projections were developed to determine if significant differences in timing existed among sectors which might allow enforcement activities to be concentrated in certain areas at specific times. With the exception of railroads, however, significant quantities of PCB's are coming up for disposal decisions each year for the next two decades. Thus, enforcement activities must begin immediately and must continue over the long term.

The PCB regulations essentially prohibit the use of PCB's in railroads after 1 January 1982. As illustrated in Exhibit II-6, 3.6 million pounds of PCB's will be removed from service over the 1979 to 1981 period. It is, therefore, necessary to quickly implement enforcement activities in the railroad sector. Resources so allocated, however, will be available for other uses after 1981.

The pounds of PCB's requiring disposal decisions in utilities and commercial buildings rises steadily from 1979 to a peak of 8 million pounds in 1992 and 6.5 million pounds in 1990, respectively. This suggests that the EPA should plan a long term enforcement program for the utility and commercial sectors.

[1]As discussed below, the railroad and commercial building sectors present unique enforcement problems. For this reason, these sectors are excluded from this plant-specific analysis.

However, there are still significant amounts of PCB's being released prior to the peak, and hence, the start of the enforcement program should not be delayed.

The industrial sector poses the most immediate threat of improper disposal of PCB's. It is, therefore, crucial to promptly implement the enforcement strategy for the industrial target groups.

METHODOLOGY FOR DERIVING ESTIMATES BY TARGET GROUPS

There currently exist no records of PCB transformer and capacitor installations by target group. It was therefore necessary to estimate for each target group the number of transformers and capacitors installed each year, the number of transformers and capacitors which were still in service at the end of 1979 and, finally, when each of these transformers and capacitors would be removed from service. The methodology for doing this is described briefly below.[1]

Transformers are used to step up or step down the voltage level of a current of electricity. Capacitors are used to regulate the flow of electric current. Since both transformers and capacitors are used to conduct or regulate the flow of electricity, it was assumed that the installation of transformers and capacitors within each sector and industry would be proportional to that sector or industry's use of electricity. Thus, estimates of total existing PCB transformers and capacitors from previous work by Versar, Inc., were allocated to sectors and industries based on electricity use.

[1]A more detailed discussion is presented in Appendix A.

Once the total existing PCB capacitor and transformer installations were determined for each industry, the number of installations each year over the period from 1945 to 1975 was determined. These years were selected since they represent the period in which PCB-containing equipment was manufactured and sold. The number of installations in each year of this period was estimated using the pattern of the sector or industry's capital expenditures. A computer simulation program then was used to project the year in which the equipment would be removed from service given the initial installation date, an average failure rate and an average lifetime.[1] Note that no specific adjustment was made for possible early removal motivated by EPA regulations or other factors.

Due to the large number of firms within each industry and the diversity of firm sizes, PEB next allocated the number of PCB transformers and capacitors existing in 1979 to target groups within each industry. To define the target groups of interest within each industry, two steps were taken:[2]

1. Subsegments of the industry which represent the ten largest users[3] of electricity within each industry were selected.

---

[1]In the case of transformers, the lifetime may be extended by several years by rebuilding the transformer at the end of its initial service life. If the transformer was rebuilt prior to 1975, it was assumed that the PCB fluid was replaced in kind. After 1975, it was assumed that the replacement fluid did not contain PCB's. If the transformer is rebuilt, the PCB's initially in the transformer are removed from service at that time.

[2]See Appendix A for a more detailed explanation of this procedure.

[3]Users are defined here by four-digit Standard Industrial Classification code (SIC).

2. The plants within these ten largest electricity users were divided into the five target groups defined in Exhibit II-1.

It was assumed that the subsegments selected within the industry would have all of the PCB transformers and capacitors within that industry. Further, across the five target groups the number of PCB transformers and capacitors was assumed to be proportional to output.[1] For example, if the four largest firms (the first target group) accounted for twenty percent of the output of all five target groups, twenty percent of the PCB transformers and capacitors are assumed to be in plants owned by these four firms.

The utility sector was also divided into five target groups in the manner described above, while the commercial and railroad sectors were each defined as a single target group. The time pattern of PCB disposal decisions was assumed to be the same for each target group within an industry or sector.

[1]Dollar value of shipments is a widely accepted measure of output and was used for each target group.

TARGET GROUPS FOR TSCA/PCB ENFORCEMENT STRATEGY

SECTOR	INDUSTRY	TARGET GROUP
INDUSTRIAL	Stone, Clay and Glass Food Mining Textiles Paper and Lumber Metals Chemicals Automobiles	1. Four largest companies within an industry. 2. Next four companies within an industry. 3. Next twelve companies within an industry. 4. Next thirty companies within an industry. 5. Remaining companies within an industry.
UTILITIES		1. Four largest utilities within an industry. 2. Next four utilities within an industry. 3. Next twelve utilities within an industry. 4. Next thirty utilities within an industry. 5. Remaining utilities within an industry.
COMMERCIAL BUILDINGS		COMMERCIAL BUILDINGS
RAILROADS		RAILROADS

TRANSFORMERS IN SERVICE BY TARGET GROUP - 1979

TOTAL	SECTOR	INDUSTRY	TARGET GROUP	
TOTAL 125,024	INDUSTRIAL 51,354	METALS 15,841	8,190	Top 4 Firms
			2,344	Next 4 Firms
			2,487	Next 12 Firms
			1,537	Next 30 Firms
			1,283	All Remaining Firms
		CHEMICALS 14,606	5,755	Top 4 Firms
			2,395	Next 4 Firms
			3,199	Next 12 Firms
			2,308	Next 30 Firms
			949	All Remaining Firms
		PAPER & LUMBER 7,840	2,164	Top 4 Firms
			1,043	Next 4 Firms
			1,568	Next 12 Firms
			1,325	Next 30 Firms
			1,740	All Remaining Firms
		MINING 2,771	748	Top 4 Firms
			305	Next 4 Firms
			333	Next 12 Firms
			1,385	Next 30 Firms
			0	All Remaining Firms
		AUTOMOBILES 2,485	2,312	Top 4 Firms
			124	Next 4 Firms
			12	Next 12 Firms
			12	Next 30 Firms
			25	All Remaining Firms
		FOOD 3,347	777	Top 4 Firms
			435	Next 4 Firms
			502	Next 12 Firms
			499	Next 30 Firms
			1,134	All Remaining Firms
		TEXTILES 2,051	624	Top 4 Firms
			259	Next 4 Firms
			413	Next 12 Firms
			398	Next 30 Firms
			342	All Remaining Firms
		STONE, CLAY & GLASS 2,431	1,260	Top 4 Firms
			369	Next 4 Firms
			417	Next 12 Firms
			220	Next 30 Firms
			147	All Remaining Firms
	UTILITY 38,327		5,513	Top 4 Firms
			3,300	Next 4 Firms
			6,334	Next 12 Firms
			8,736	Next 30 Firms
			14,444	All Remaining Firms
	COMMERCIAL BUILDINGS 34,015		34,015	All Buildings
	RAILROAD 828		828	All Railroads with PCB Equipment

CAPACITORS IN SERVICE BY TARGET GROUP - 1979
(thousands of units)

TOTAL	SECTOR	INDUSTRY		TARGET GROUP
TOTAL 2,943	INDUSTRIAL 825	METALS 241	125	Top 4 Firms
			36	Next 4 Firms
			38	Next 12 Firms
			23	Next 30 Firms
			19	All Remaining Firms
		CHEMICALS 232	91	Top 4 Firms
			38	Next 4 Firms
			51	Next 12 Firms
			37	Next 30 Firms
			15	All Remaining Firms
		PAPER & LUMBER 124	34	Top 4 Firms
			16	Next 4 Firms
			25	Next 12 Firms
			21	Next 30 Firms
			28	All Remaining Firms
		MINING 57	15	Top 4 Firms
			6	Next 4 Firms
			7	Next 12 Firms
			29	Next 30 Firms
			0	All Remaining Firms
		AUTOMOBILES 42	39	Top 4 Firms
			2	Next 4 Firms
			0.2	Next 12 Firms
			0.2	Next 30 Firms
			0.4	All Remaining Firms
		FOOD 55	13	Top 4 Firms
			7	Next 4 Firms
			8	Next 12 Firms
			8	Next 30 Firms
			19	All Remaining Firms
		TEXTILES 33	10	Top 4 Firms
			4	Next 4 Firms
			7	Next 12 Firms
			6	Next 30 Firms
			6	All Remaining Firms
		STONE, CLAY & GLASS 41	21	Top 4 Firms
			6	Next 4 Firms
			7	Next 12 Firms
			4	Next 30 Firms
			3	All Remaining Firms
	UTILITY 1,339		190	Top 4 Firms
			114	Next 4 Firms
			235	Next 12 Firms
			301	Next 30 Firms
			498	All Remaining Firms
	COMMERCIAL BUILDINGS 779		779	All Buildings
	RAILROAD 0		0	All Railroads with PCB Equipment

AVERAGE NUMBER OF TRANSFORMERS/PLANT[1]
BY TARGET GROUP - 1979

TOTAL	SECTOR	INDUSTRY		TARGET GROUP
TOTAL	INDUSTRIAL	METALS	20.6	Top 4 Firms
			17.1	Next 4 Firms
			9.0	Next 12 Firms
			4.7	Next 30 Firms
			0.6	All Remaining Firms
		CHEMICALS	11.6	Top 4 Firms
			9.3	Next 4 Firms
			10.3	Next 12 Firms
			5.0	Next 30 Firms
			0.7	All Remaining Firms
		PAPER & LUMBER	4.8	Top 4 Firms
			3.3	Next 4 Firms
			3.1	Next 12 Firms
			2.3	Next 30 Firms
			0.2	All Remaining Firms
		MINING	0.5	Top 4 Firms
			0.5	Next 4 Firms
			0.5	Next 12 Firms
			0.5	Next 30 Firms
			0	All Remaining Firms
		AUTOMOBILES	39.9	Top 4 Firms
			11.3	Next 4 Firms
			0.7	Next 12 Firms
			0.4	Next 30 Firms
			0.2	All Remaining Firms
		FOOD	1.3	Top 4 Firms
			1.1	Next 4 Firms
			0.3	Next 12 Firms
			0.7	Next 30 Firms
			0.1	All Remaining Firms
		TEXTILES	2.5	Top 4 Firms
			1.3	Next 4 Firms
			1.7	Next 12 Firms
			1.3	Next 30 Firms
			0.1	All Remaining Firms
		STONE, CLAY & GLASS	3.4	Top 4 Firms
			2.2	Next 4 Firms
			1.3	Next 12 Firms
			0.7	Next 30 Firms
			0.1	All Remaining Firms
	UTILITY		15.3	Top 4 Firms
			15.3	Next 4 Firms
			15.3	Next 12 Firms
			15.3	Next 30 Firms
			15.3	All Remaining Firms

Note: Transformers per site for commercial buildings and railroads have not been estimated.

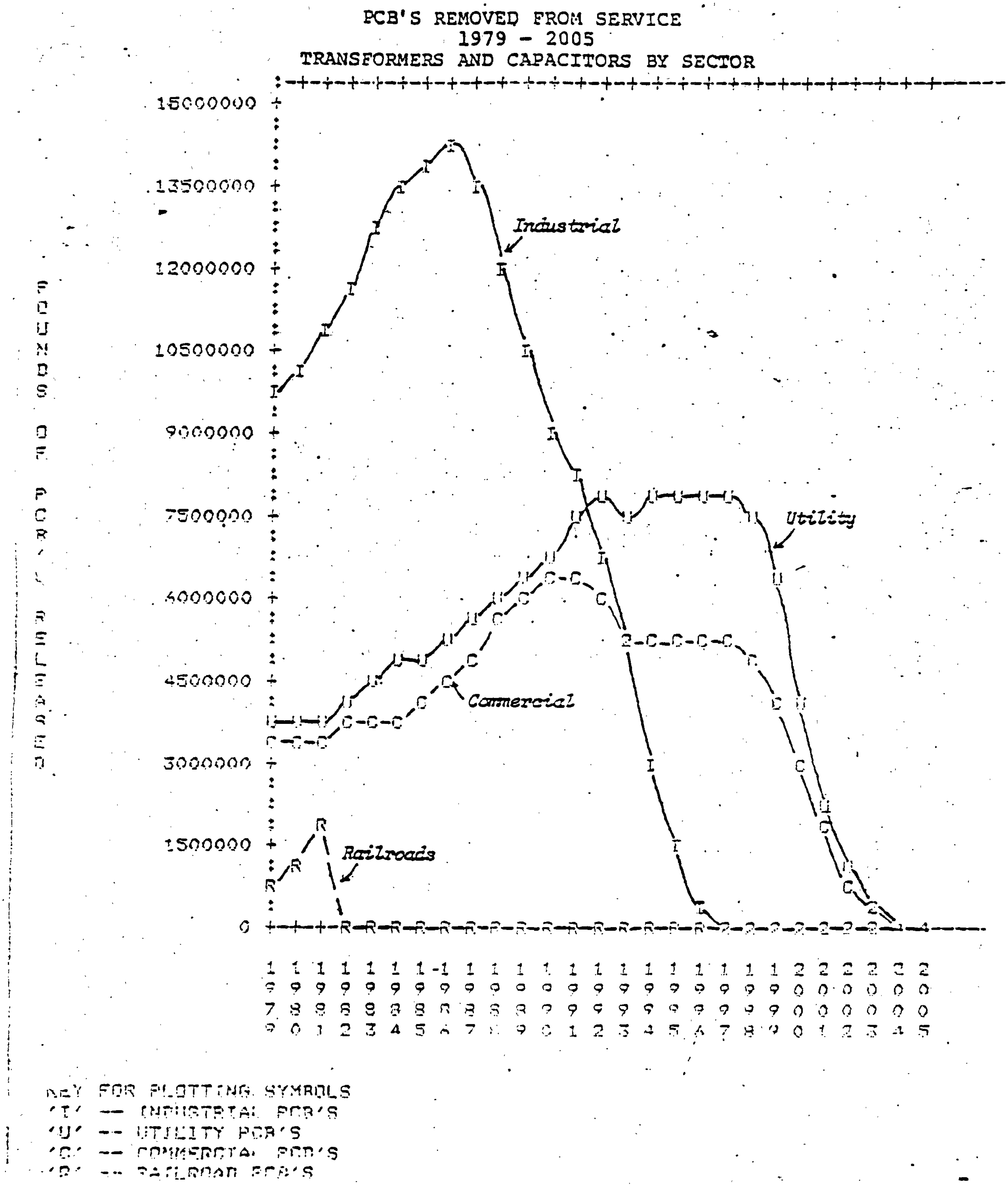
[1]Transformers per plant by target group is computed by dividing the data in Exhibit II-2 by the number of plants in each target group. See Appendix A for a detailed discussion.

AVERAGE NUMBER OF CAPACITORS/PLANT[1] BY TARGET GROUP - 1979

TOTAL	SECTOR	INDUSTRY		TARGET GROUP
TOTAL	INDUSTRIAL	METALS	314.1	Top 4 Firms
			262.8	Next 4 Firms
			137.2	Next 12 Firms
			70.3	Next 30 Firms
			8.6	All Remaining Firms
		CHEMICALS	183.8	Top 4 Firms
			147.3	Next 4 Firms
			164.0	Next 12 Firms
			79.4	Next 30 Firms
			10.8	All Remaining Firms
		PAPER & LUMBER	75.2	Top 4 Firms
			50.6	Next 4 Firms
			49.1	Next 12 Firms
			35.7	Next 30 Firms
			2.9	All Remaining Firms
		MINING	9.5	Top 4 Firms
			9.5	Next 4 Firms
			9.5	Next 12 Firms
			9.5	Next 30 Firms
			0	All Remaining Firms
		AUTOMOBILES	673.5	Top 4 Firms
			191.9	Next 4 Firms
			12.4	Next 12 Firms
			7.0	Next 30 Firms
			3.6	All Remaining Firms
		FOOD	16.2	Top 4 Firms
			18.2	Next 4 Firms
			15.1	Next 12 Firms
			10.8	Next 30 Firms
			1.6	All Remaining Firms
		TEXTILES	42.5	Top 4 Firms
			29.0	Next 4 Firms
			27.0	Next 12 Firms
			15.3	Next 30 Firms
			2.7	All Remaining Firms
		STONE, CLAY & GLASS	58.5	Top 4 Firms
			37.1	Next 4 Firms
			29.9	Next 12 Firms
			11.3	Next 30 Firms
			1.3	All Remaining Firms
	UTILITY		528.2	Top 4 Firms
			528.2	Next 4 Firms
			528.2	Next 12 Firms
			528.2	Next 30 Firms
			528.2	All Remaining Firms

Note: Transformers per site for commercial buildings and railroads have not been estimated.

[1]Capacitors per plant by target group is computed by dividing the data in Exhibit II-3 by the number of plants in each target group. See Appendix A for a detailed discussion.


PCB'S REMOVED FROM SERVICE
1979 - 2005
TRANSFORMERS AND CAPACITORS BY SECTOR
POUNDS OF PCB'S RELEASED
15000000
13500000
12000000
10500000
9000000
7500000
6000000
4500000
3000000
1500000
0
Industrial
Utility
Commercial
Railroads
KEY FOR PLOTTING SYMBOLS
'I' -- INDUSTRIAL PCB'S
'U' -- UTILITY PCB'S
'C' -- COMMERCIAL PCB'S
'R' -- RAILROAD PCB'S

The objective of the awareness component of the PCB enforcement strategy is to maximize voluntary compliance; that is, to encourage compliance at a plant or facility in the absence of any direct enforcement effort there.

Awareness efforts aimed at individuals who will make PCB disposal decisions are one of the major enforcement tools available to EPA. Although such efforts can be very inexpensive on a per plant or per firm basis, their effectiveness is likely to be limited unless the suspected cause of noncompliance is lack of knowledge about the TSCA/PCB regulations, the sanctions available to EPA, or the Agency's enforcement efforts. Thus, to maximize the overall effectiveness of EPA's PCB enforcement efforts, resources should be spent on awareness efforts which are aimed at target groups, industries or sectors where these problems arise.

There are two parts to the recommended awareness component — the distribution of PCB information and inspection support. Each of these parts is described below. These awareness activities should be considered as continuing efforts by the Agency.

DISTRIBUTION OF PCB INFORMATION

The first part of the awareness component attempts to increase knowledge of the PCB regulations, disposal options, and enforcement efforts among those industries that have a large amount of PCB equipment. There are two levels to this effort.

The initial level of the effort will be directed toward industries where current levels of awareness are low. These industries must be informed, through communication with company headquarters and/or plants, of the following issues:

- The health hazards of exposure to PCB's,
- The disposal, marking and recordkeeping regulations,
- An interpretation of what actions are required by the regulations, and
- A discussion of the sanctions available to the Agency in the event of noncompliance.

Facilities should also be instructed on how to contact EPA when questions arise about the PCB program.

Selection of the industries which will be the principal beneficiaries of this part of the awareness component is based on several measures of current knowledge. The information needed to rank the industries was provided in most cases by interviews with industry representatives.

The interview responses show that certain industries have far better information about PCB's than do others, as indicated in the table below. There are three basic levels of awareness upon which industries were ranked. First is a basic knowledge of PCB's as a hazardous chemical substance; second is knowledge of the PCB regulations and the compliance requirements; and third is awareness of the possible costs of compliance on the industry.

TABLE III-1

INDUSTRY AWARENESS OF PCB'S

	AWARENESS			
INDUSTRY	NO AWARENESS	PCB'S A HAZARDOUS CHEMICAL	PCB REGULATIONS	COST OF COMPLIANCE
Utilities		•	•	•
Textiles	•			
Paper		•	•	•
Stone, Clay & Glass	•			
Steel		•	•	
Non-Ferrous Metals	•			
Railroads		•		
Food		•		
Automobiles		•	•	
Commercial Buildings*	•			
Chemicals		•	•	•
Mining		•	•	

Those industries that already know about the nature of PCB's <u>and</u> about the regulations are as aware as the first level of the PCB awareness program could make them. The resources dedicated to this level should therefore concentrate on the industries or sectors which appear to be relatively ignorant of their compliance requirements. These industries, based on the table above, are:

- Textiles
- Stone, Clay and Glass
- Non-Ferrous Metals
- Railroads
- Food
- Commercial Buildings

The second level of effort is the provision of updated information about PCB's and PCB issues. Such information should be distributed, possibly through large audience publicity techniques, to all PCB user industries. PCB users should also be kept informed of their legal disposal options. Some options, such as the opening of new approved incinerators or storage facilities, may lower the costs of compliance and thus further encourage voluntary compliance.

INSPECTION SUPPORT

The second part of the overall awareness component directs information specifically toward the target groups receiving inspection activity. The success of the inspection component relies strongly on the assumption that decision makers in target groups will make the choice for proper disposal only if they are aware of their likelihood of inspection, their costs of compliance and the likely fine should a violation be detected. Providing and updating this information is therefore an important part of the awareness effort.

The Agency can rely on private channels of communication to distribute important information (such as PCB compliance costs) to target group members of more organized industries. However, special efforts should be undertaken for the target groups within those industries when communication among members is limited.

The information used to determine which industries are likely to have poor communication, and where, therefore, special effort is required, was taken from interviews with industry representatives. Industry associations were questioned about the existence of regular and frequent channels of communication (for example, industry newsletter) and whether environmental committees existed and distributed environmental information. The results are shown below.

TABLE III-2

INDUSTRY COMMUNICATION CHANNELS

INDUSTRY	LITTLE COMMUNI-CATION	NEWS-LETTERS	OTHER CHANNELS	ENVIRON-MENTAL COMMITTEES
Utilities		●		●
Textiles	●			
Paper		●		●
Stone, Clay & Glass	●			
Non-Ferrous Metals			●	
Railroads			●	
Food*	●			
Automobiles		●		
Commercial Buildings*	●			
Chemicals		●		●
Mining		●		●
Steel		●		●

*Estimated.

Target groups in industries which have at least one form of regular and/or frequent communication and in addition have a formal committee which keeps members alert to environmental issues are likely to learn of PCB developments on their own. However, target groups in industries without such organization may not. These industries, whose target groups will need extra awareness efforts, are:

- Textiles
- Stone, Clay and Glass
- Non-Ferrous Metals
- Railroads
- Food
- Commercial Buildings

The objective of the inspection component of the TSCA/PCB enforcement strategy is to provide a direct physical presence at a sufficient number of plants and facilities where PCB disposal decisions are made to insure compliance with the regulations. The impact of a single inspection is not limited to the site inspected. Rather, it combines with all other inspections to build a perceived risk of discovery and resulting sanction that is sufficient to encourage decision makers faced with PCB disposal decisions to favor compliance over noncompliance.

Inspections are one of a variety of enforcement tools available to EPA. Research by PEB indicated that inspection activities have been found to be effective by a number of regulatory agencies. In particular, the U.S. Food and Drug Administration (FDA) has carried out research concerning the relative effectiveness of a variety of inspection programs.[1] This research indicated several important considerations for the development of the TSCA/PCB inspection component:

1. Inspections based solely on complaints were found to be a poor use of the FDA's resources.

2. Inspections which were followed up by a letter to the company's headquarters (not the site inspected) summarizing the results of the inspection, the required action, and the possible sanctions for continued noncompliance were particularly effective.

[1] See Appendix B for further information on the FDA results.

3. Inspections which concluded with the issue of a formal citation actually hindered quick remedy of the violation.

As described in Chapter I, the overall goal of the TSCA/PCB enforcement strategy is to minimize the amount of PCB's released to the environment through minimizing disposal violations. Other technical violations of the regulations, although important, are not as critical as illegal disposal. It is difficult, however, to implement inspection activities so as to detect disposal violations directly. To solve this difficulty, the inspection component as well as the entire enforcement strategy depends upon PCB records as an acceptable indicator and motivator of compliance. Maintenance of accurate records by a plant or facility provides a measure of overall compliance as well as an indicator and audit trail for specific violations. The practical intent of the inspection component, therefore, is to foster and verify the creation and maintenance of complete and accurate PCB records.

The inspection component will focus on three categories of sectors and industries which require different approaches to inspection. Each of these approaches, however, seeks to maximize inspection effectiveness by allocating inspections to target groups where the inspection will be most effective in causing PCB's to be disposed of properly. The first category includes all utility and industrial users of PCB transformers and capacitors. The second is made up of commercial buildings that use PCB equipment. Railroads that use PCB transformer-equipped locomotives comprise the third category. In addition, some inspection resources will be allocated to complaint response and emergency situations. The remainder of this chapter presents the recommended inspection activity in each of these areas.

UTILITY AND INDUSTRIAL USERS

Utility and industrial users contain the largest numbers of PCB transformers and capacitors, and inspection activity in target groups in these two sectors is found to be relatively effective. The material below describes the activities carried out on an inspection and the scheduling of inspections to specific target groups.

Inspection Activities

Most inspections will be audit inspections in which records of PCB equipment are sampled and verified. There are two types of the basic audit inspection, which are distinguished from each other by the kind of PCB equipment of primary interest. In the first type, the inspector will audit all records but will verify transformer records only. In the second, the inspection will verify both transformer and capacitor records. This type is termed a "joint" inspection. In both types of inspections, all records will be examined by the inspector. The fundamental difference in inspection types lies in which records will be physically verified.

A distinction was made between these two types due to their cost differential, which becomes important when inspection resources are distributed to achieve maximum effectiveness. Although the exact costs of the two types is not currently known, it is clear that a joint inspection, which requires more time, must be more expensive. Thus, it was assumed that a joint inspection costs 50 percent more than a transformer inspection.

In both types of inspection, similar activities must be performed. An audit of the records kept for each piece of PCB equipment must be performed, and in addition, a certain proportion of the entries will be verified by a physical check. Both of these procedures are described in more detail below.

Record Audits

In all inspections the inspector is required to examine the plant's PCB records. The inspector shall evaluate the records for compliance, for accuracy, and for completeness. Any suspicious entries, or any missing entries, will be investigated.

The inspector will also make a comparative evaluation. When historical records are available, they must be used in conjunction with the present records to determine that a complete audit trail exists for all PCB equipment.

In addition, the inspector should compare the plant records of the number and size of PCB equipment owned against standards for a representative plant. These standards should be developed by EPA based on analysis which, given any specific industry and plant configuration, can indicate the number of PCB transformers and large capacitors that should be present. The inspector will match the recorded equipment inventory to the expected; significant deviations from the standards will be investigated.

Physical Inventory Audits

A certain proportion of the records will be verified by a physical check for PCB equipment. Using the inventory of PCB equipment shown in the records, the inspector shall physically inspect a representative sample of transformers and/or large capacitors. The inspector should verify the presence of the equipment and, in some cases, the PCB content of the equipment (through chemical analysis). The proportions to be so checked should be statistically determined to achieve a minimum level of confidence regarding the overall accuracy of the records.

Inspection Scheduling

The goal of the inspection scheduling method is to allocate limited inspection resources to specific target groups so as to cause the proper disposal of the largest possible quantity of PCB's. This requires that inspections be allocated to the target groups in which they will be most effective. Estimating the effectiveness of an inspection requires an analysis of the compliance decision and the factors that influence it. The compliance decision is made by PCB equipment owners based on a variety of economic and noneconomic factors. PHB has considered both of these types of factors in calculating an inspection efficiency for each target group. The inspection efficiencies are used to develop a schedule of recommended inspections per year by target group. The steps in the determination of the inspection efficiencies and the scheduling of inspections, and a brief description of each, are presented below.

Step 1: Consideration of Economic Factors

The compliance decision based on economic factors is considered as a choice between the cost of compliance and the economic risk of noncompliance. The economic risk of noncompliance is a function of the perceived probability of inspection, the duration of the inspection effort, and the magnitude of the likely penalty if a violation is detected.[1] The perceived probability of inspection must be large enough, given the duration of the effort and the likely fine, to induce decision makers to select compliance based on economic factors. The probability of inspection, given estimates of duration and penalty, required to insure the proper disposal of a target group's PCB's can be calculated. The number of inspections required to achieve this probability is the required number of inspections to achieve full compliance based on economic factors.

Step 2: Consideration of Noneconomic Factors

Noneconomic factors affect the decision maker's likelihood of compliance irrespective of economic considerations. Such noneconomic factors include the decision maker's level of awareness of the regulations and of the PCB problem as a whole, the quality of communications channels available to the decision maker which effect the availability of information required to make informed decisions and the decision maker's attitudes toward compliance as reflected in his historical behavior when confronted with environmental regulations. These factors are assessed and combined to determine a relative likelihood of compliance for each sector and industry based on noneconomic factors. This relative likelihood is then used to adjust the required numbers of inspections for each target group to arrive at inspection requirements that reflect both economic and noneconomic factors.

---

[1]For the purposes of this analysis, PEB has assumed that violations are always detected if an inspection if performed at a noncomplying facility.

Step 3: Scheduling Inspections

Dividing the target group's quantity of PCB's by the adjusted number of inspections required yields an "inspection efficiency" for that target group. The inspection efficiencies are used in a computer model which allocates a fixed quantity of inspection resources to target groups in a manner which maximizes the quantity of PCB's properly disposed.

These steps in the inspection scheduling method for utilities and other industrial users are described in more detail below.

STEP 1: CONSIDERATION OF ECONOMIC FACTORS

The compliance decision is made after the consideration by the decision maker of the economic and noneconomic ramifications of all options involving compliance and noncompliance. The economic factors cause the decision maker to view the compliance decision as an economic choice between the cost of compliance and the economic risk of noncompliance. The economically rational decision maker will comply with the law only when his cost of compliance is less than the economic risk of noncompliance.

The cost of compliance is the sum of the various costs associated with the proper disposal of PCB equipment. These costs may include the cost of retrofilling a transformer to lower its PCB content, the cost of incinerating or otherwise disposing of, or storing PCB fluids, the implicit cost of prematurely disposing of PCB equipment, and other related costs. The cost of compliance may also vary among several compliance options, all of which are within the law.

The economic risk of noncompliance depends upon the risk of being inspected in any given year, and the dollar value of the fine imposed if caught. For example, if there is a one-year inspection program in which there is a 10 percent chance of being inspected and the fine if caught is $50,000, the economic risk (or the expected cost of noncompliance) is $5,000. EPA's inspection effort will continue, however, into the foreseeable future in order to insure the proper disposal of PCB's that will be removed from service in the next ten to twenty years. In a multi-year inspection effort there is a risk of inspection and discovery in each year of inspection activity. This makes the total economic risk of noncompliance considerably greater and allows the probability of inspection in each year of the program to be lower than would have been required to create the same perceived risk in a single year.

In carrying out this step, PHB has assumed that inspection activity aimed at enforcing the TSCA/PCB regulations will continue for at least ten years. If inspection activity is reduced or ended earlier than this, the required probabilities of inspection calculated by PHB are too low to insure compliance. In addition, PHB has assumed an average penalty of $50,000 for each transformer or capacitor disposal violation discovered.[1]

Although the calculations required to compute the probability of inspection needed to equalize compliance and noncompliance costs are essentially the same for transformers and capaci-

[1]Analysis of the likely disposal violations indicate that if 2000 pounds of PCB's are disposed of illegally (equivalent to one PCB transformer or 43 capacitors), a $25,000 disposal fine and a $20,000 marking violation fine are likely to be imposed. It is further assumed that a $10,000 recordkeeping violation fine will be imposed in half of the cases. This results in a $45,000 to $55,000 average fine with a median value of $50,000.

required to insure that the decision to comply with be economically preferable for each target group calculated. In reality, however, the decision is also influenced by noneconomic factors which are unaffected by the economic circumstances. The derivation of the required probability of inspection assumes that the compliance decision is made on the basis of economic factors and perfect information. This means that no decision maker in a target group will comply until the probability of inspection makes the expected cost of noncompliance higher than the cost of compliance. As soon as the cost of noncompliance is higher, however, all decision makers in a target group will immediately choose to comply. This behavior is represented graphically in Figure A of Exhibit IV-1.

In reality, of course, the costs of compliance and noncompliance are uncertain. The quality of the information and the ability to interpret it will vary between individuals. Some owners will be better able to judge the "true" economic and regulatory situation than others. These considerations lead one to expect a somewhat smooth shift toward compliance as the probability of inspection increases. This behavior is represented in Figure B of Exhibit IV-1. In Figure C of Exhibit IV-1, a straight-line approximation of this shift is diagrammed. Such an approximation was assumed to simplify later computations.

In order to adjust the required probability of inspection to approximate the smooth shift behavior explained above, the probabilities were increased by a percentage proportional to the ambiguity of the compliance decision and the likelihood of decision error. The adjusted probability represents the probability of inspection at which all decision makers in a target group choose to comply given the smooth linear shift described above. This is illustrated in Figure C of Exhibit IV-1. The ad justed required probabilities of inspection by target group are presented in Exhibit IV-2.

The number of inspections required to achieve the required probability of inspection can be calculated using the number of plants and pieces of PCB equipment in each target group. The method of computation differs slightly for transformers and capacitors due to the assumption that a separate compliance decision is made for each transformer while capacitors are the subject of a single, plant-wide compliance decision. An example computation for the chemical industry appears in Exhibit IV-3. For a full discussion of the methodology for calculating the required numbers of inspections, see Appendix C.

There are, however, other noneconomic factors which affect the compliance decision. These noneconomic factors combine to determine a relative likelihood of compliance for each sector and industry which is used to adjust the required number of inspections determined on an economic basis.

These noneconomic factors and their effect on the likelihood of compliance are listed below:

- Quality of Information Flow. Inasmuch as rapid and accurate information flow is crucial to the accurate perception of the options and risks facing the decision maker, industries with well-developed communication channels (such as those created by industry associations) are more likely to understand their choices and make economically rational decisions.

- Degree of Industry Concentration. Concentrated industries are able to communicate information more effectively. Decisions in concentrated industries also effect greater quantities of PCB's, thus making widespread compliance easier to achieve.

- **Level of Awareness of PCB Regulations.** Industries already aware of the PCB regulations are more likely to comply inasmuch as noncompliance due to ignorance is less likely.

- **Compliance History.** Industries with a history of noncompliance and resistance to environmental regulations can be expected to resist complying with PCB regulations.

Each of these factors is considered in a comparative ranking technique used to quantify each sector and industry's resistance to compliance based on noneconomic factors. The results of the comparative ranking are used to adjust the required number of inspections to achieve full compliance for each target group by as much as a twenty percent increase or decrease. If the likelihood of compliance is high for an industry, the required number of inspections for the industry's target group is reduced by as much as twenty percent to allow for a higher expected effectiveness for an inspection in that industry. The adjusted number of inspections required to insure that all of a target group's PCB's are properly disposed is presented in Exhibit IV-4 for each target group. Appendix D contains a complete discussion of the calculation of the adjusted required number of inspections.

STEP 3: SCHEDULING INSPECTIONS

The adjusted number of inspections required for full compliance are used to calculate inspection efficiencies which can then be used to schedule inspection resources in the most effective manner.

Inspection efficiencies are computed by dividing the pounds of PCB's properly disposed (assumed to be 100 percent of the target group's transformer and capacitor PCB's) by the number of inspections needed to raise the probability of inspection t the required level for a given target group. This computation assumes that the increase in PCB's properly disposed for each additional inspection is constant.[1] Although inspection efficiency may be expected to diminish as the amount of properly disposed PCB's approaches 100 percent, this approximation is considered to be sufficiently accurate for the purpose of allocating inspections comparatively among target groups. Exhibit IV-3 provides an example of these calculations for target groups in the chemicals industry.

After computing the inspection efficiencies as described above, the efficiencies can be used to allocate inspection resources to target groups in the most efficient manner in order to maximize the pounds of properly disposed PCB's. To accomplish this task, a computer model was prepared that allocates a limited number of inspection resources to specific target groups. The model finds the allocation of inspections that results in the maximum quantity of properly disposed PCB's through use of linear programming, an analytic technique useful for calculating the optimal use of limited resources. The program allocates inspections to target groups with the highest inspection efficiencies until available inspection resources are exhausted. Some target groups with low inspection efficiencies thus are not inspected. A complete discussion of the model and its operation is included in Appendix E.

The output of the model is a schedule of the number of inspections that should be allocated to each target group each year. As described previously, inspections have been divided into two types. The first concerns itself with transformer records

[1]This could be described graphically by a straight line drawn from the origin to the point on the smoothed curve above the adjusted risk of inspection as in Figure C, Exhibit IV-1.

only at a given site, and the second examines both transformer and capacitor records. The model stipulates the use of a joint inspection only when the added cost of the inspection of capacitors as well as transformers at a given site results in a larger quantity of properly disposed PCB's than if the additional resources were expended elsewhere.[1]

The results of the computer model are shown in Exhibit IV-5. Four hundred of the five hundred available inspections were allocated to utility and industrial target groups.[2] One hundred inspections were reserved for commercial building and railroad target groups and emergencies.

COMMERCIAL BUILDINGS

Commercial buildings, generally offices or public buildings, can contain PCB transformers and capacitors used for general electricity requirements. These buildings are scattered throughout the U.S. and the concentration of PCB equipment in any target group of users is expected to be low. Further, it is also anticipated that building owner/operators are unaware of the PCB problem and the extent to which their equipment may contain PCB's. These considerations suggest that the inspection efficiency for commercial buildings will be so low as to require many hundreds of inspections to achieve a significant level of compliance.

---

[1]Although the cost of a joint transformer and capacitor inspection is known to be greater than the cost of a transformer inspection alone, the exact cost is currently unknown. Thus it was assumed that a joint inspection required 50 percent more resources than a transformer inspection.

[2]The 500 available inspections were assumed to be joint inspections.

It is reasonable to assume that when disposal of PCB equipment is required, many commercial buildings will contract for disposal services from transformer and capacitor service companies. Thus, it is recommended that fifty inspections be directed to the organizations[1] in the U.S. who offer such disposal and replacement services to commercial buildings. As discussed in Chapter II, it is estimated that PCB equipment in commercial buildings will be removed from service in greater quantities in later years. Thus, this inspection level should be increased as the peak decision period approaches. Such an increase will strengthen the integrity of proper disposal methods in service organizations, thus maximizing the amount of PCB equipment presently in commercial buildings that is disposed of properly. Activities on these inspections should include both examination and verification of records concerning work completed and review of procedures being utilized for the removal, storage and disposal of PCB's.

RAILROADS

Currently there are over 800 PCB transformers containing over 3.2 million pounds of PCB's in electric locomotives. These locomotives are owned by only six of the railroads in the U.S. Further, these PCB's are mandated for removal by 1982. This accelerated schedule will require intensive effort in the next several years to insure proper disposal of these PCB fluids. This effort must be intense enough to insure that PCB's in these mobile and widely distributed pieces of equipment are not subject to improper disposal. Thus, twenty inspections are targeted for railroad shop inspections to insure that all owners of PCB

[1]Approximately 30 to 50 such organizations are thought to exist by Versar, Inc.

transformers in locomotives are inspected at least once each year until the last of the PCB equipment is removed from service in 1982. Activities on these inspections should include both examination and verification of locomotive transformer records and review of procedures being utilized for removal, storage and disposal of PCB's.

EMERGENCY AND CRISIS RESPONSE

The remaining thirty inspections available should be reserved for emergency situations that arise due to reports of improper PCB disposal or handling. Inspections should be ordered upon an evaluation of the emergency situation by appropriate EPA enforcement personnel.

THEORETICAL VS. REAL WORLD COMPLIANCE BEHAVIOR

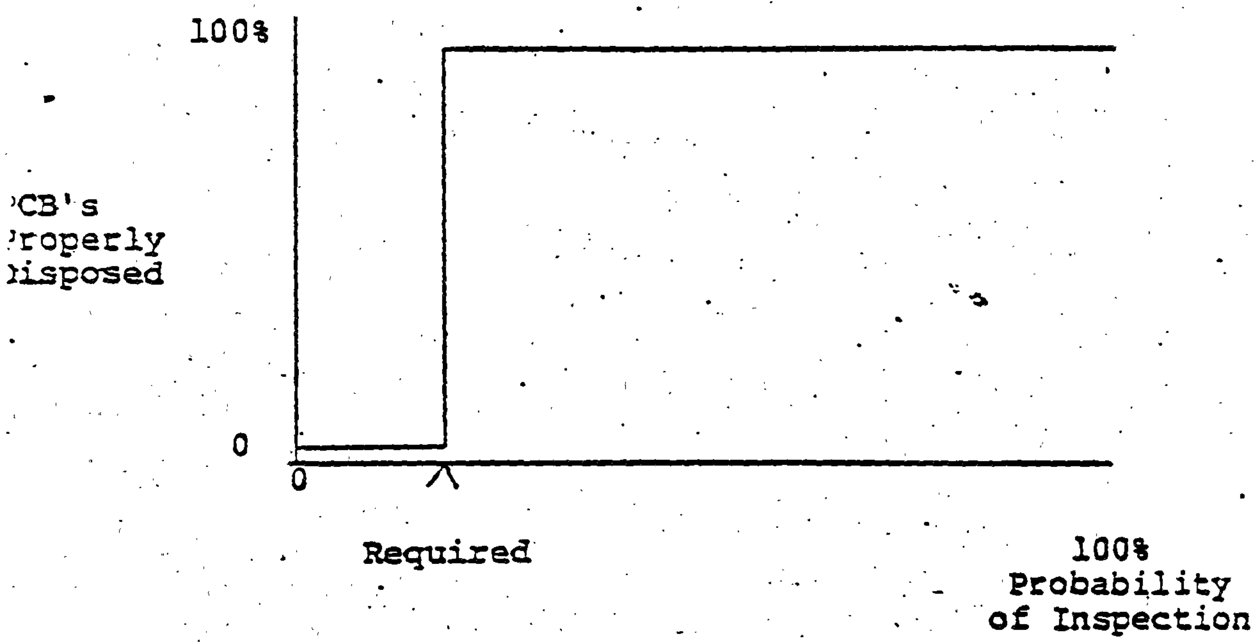


FIGURE A: THEORETICAL BEHAVIOR

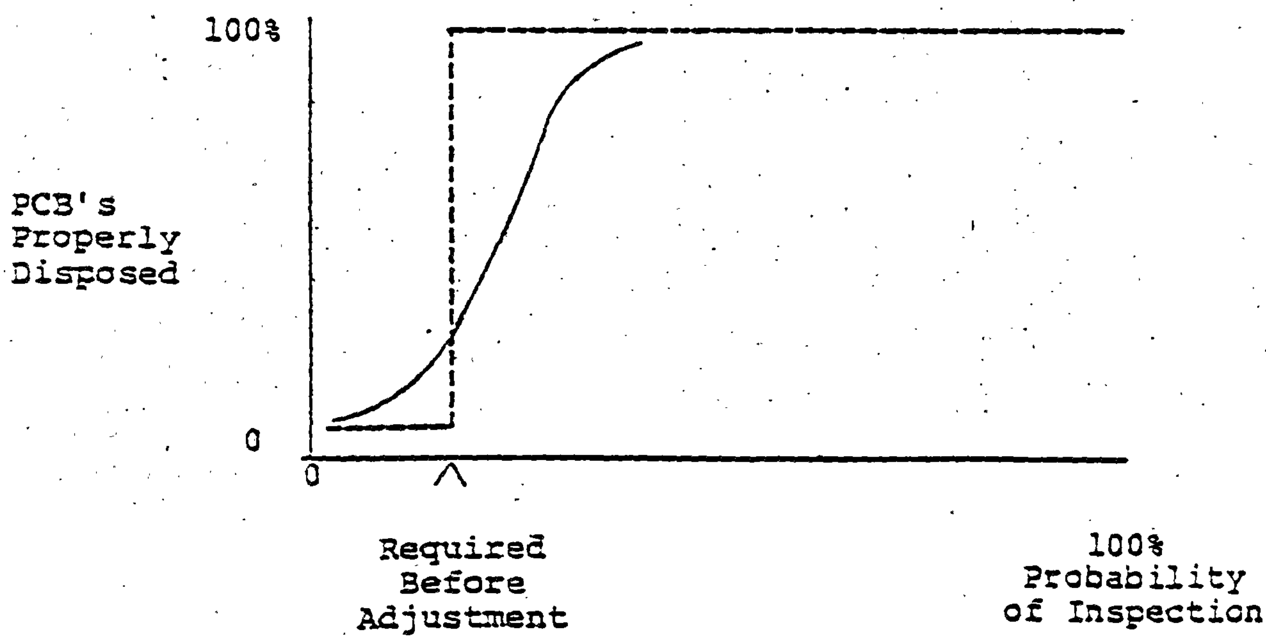


FIGURE B: ACTUAL BEHAVIOR

THEORETICAL VS. REAL WORLD COMPLIANCE BEHAVIOR
(continued)

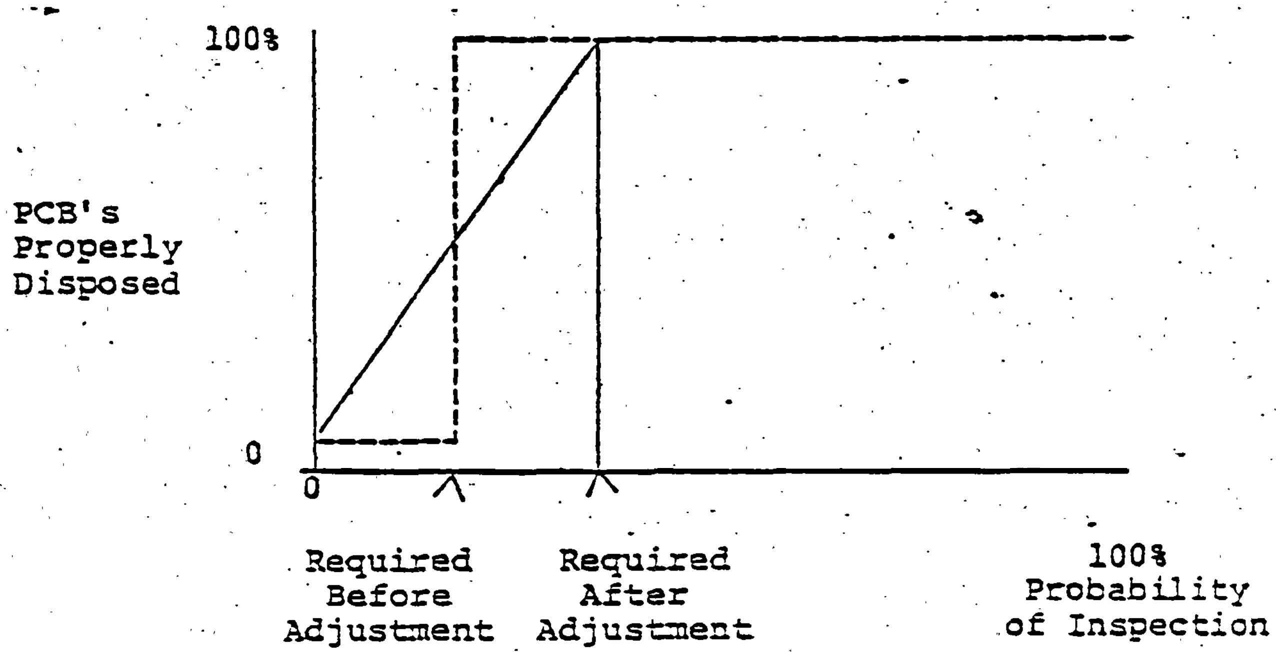


FIGURE C: LINEAR APPROXIMATION

ADJUSTED REQUIRED PROBABILITIES OF INSPECTION[1]
UTILITIES AND INDUSTRIAL TARGET GROUPS
(Annual)

INDUSTRY TARGET GROUP	REQUIRED PROBABILITY OF INSPECTION FOR: TRANSFORMERS	CAPACITORS
UTILITIES	3.0%	
Top 4 Companies		7.9%
Next 4 Companies		7.9%
Next 12 Companies		7.9%
Next 30 Companies		7.9%
Remaining Companies		7.9%
AUTOMOBILE	3.0%	
Top 4 Companies		19.3%
Next 4 Companies		5.5%
Next 12 Companies		0.4%
Next 30 Companies		0.2%
Remaining Companies		0.1%
FOOD	3.0%	
Top 4 Companies		0.5%
Next 4 Companies		0.5%
Next 12 Companies		0.4%
Next 30 Companies		0.3%
Remaining Companies		0.05%
METAL	3.0%	
Top 4 Companies		9.0%
Next 4 Companies		7.5%
Next 12 Companies		3.9%
Next 30 Companies		2.0%
Remaining Companies		0.3%
TEXTILES	3.0%	
Top 4 Companies		1.2%
Next 4 Companies		0.8%
Next 12 Companies		0.8%
Next 30 Companies		0.4%
Remaining Companies		0.08%

INDUSTRY TARGET GROUP	REQUIRED PROBABILITY OF INSPECTION FOR: TRANSFORMERS	CAPACITORS
STONE, CLAY & GLASS	3.0%	
Top 4 Companies		1.7%
Next 4 Companies		1.1%
Next 12 Companies		0.8%
Next 30 Companies		0.3%
Remaining Companies		0.1%
PAPER & LUMBER	3.0%	
Top 4 Companies		2.1%
Next 4 Companies		1.5%
Next 12 Companies		1.4%
Next 30 Companies		1.0%
Remaining Companies		0.1%
MINING	3.0%	
Top 4 Companies		0.3%
Next 4 Companies		0.3%
Next 12 Companies		0.3%
Next 30 Companies		0.3%
Remaining Companies		0.3%
CHEMICALS	3.0%	
Top 4 Companies		5.3%
Next 4 Companies		4.2%
Next 12 Companies		4.7%
Next 30 Companies		2.3%
Remaining Companies		0.3%

[1]Probabilities are those required to insure the proper disposal of all of a target group's PCB's. Probabilities have been adjust for behavioral factors. Probabilities are expressed as a percent target group transformers for PCB transformers and as a percent of target group plants for capacitors reflecting differences in the compliance decision for each. See Appendix C for a detailed discussion of the derivation of these probabilities.

COMPUTATION OF INSPECTION REQUIREMENTS AND INSPECTION EFFICIENCIES FOR THE CHEMICAL INDUSTRY

TRANSFORMERS

TARGET GROUP	REQUIRED[1] PROBABILITY OF INSPECTION	NUMBER OF[2] TRANSFORMERS	TRANSFORMERS[3] PER PLANT	REQUIRED[4] NUMBER OF PLANT INSPECTIONS	PCB'S IN[5] TARGET GROUP (mm lbs.)	INSPECTION EFFICIENCY (mm lbs. PCB/Inspectio
Top 4 Companies	3%	5755	11.6	15	11.34	0.756
Next 4 Companies	3%	2395	9.3	8	4.72	0.590
Next 12 Companies	3%	3199	10.3	9	6.30	0.700
Next 30 Companies	3%	2308	5.0	14	4.55	0.325
Remaining Companies	3%	949	0.7	42	1.89	0.045

CAPACITORS

TARGET GROUP	REQUIRED[1] PROBABILITY OF INSPECTION	NUMBER OF[7] PLANTS	REQUIRED[8] NUMBER OF PLANT INSPECTIONS	PCB'S IN[9] TARGET GROUP (mm lbs.)	INSPECTION EFFICIENCY((mm lbs. PCB/Inspectio
Top 4 Companies	5.3%	495	26	6.86	0.264
Next 4 Companies	4.2%	258	11	2.86	0.260
Next 12 Companies	4.7%	311	15	3.81	0.254
Next 30 Companies	2.3%	466	11	2.75	0.250
Remaining Companies	0.3%	1401	4	1.13	0.283

[1]Source: Exhibit IV-1.
[2]Source: Exhibit II-2.
[3]Source: Exhibit II-4.
[4]Required Number of Plant Inspections = (Required Probability of Inspection x Number of Transformers) ÷ Transformers per Plant. See Appendix C for further discussion of this calculation.
[5]PCB's in Target Group = Number of Transformers x 1,969 Pounds per Transformer.
[6]Inspection Efficiency = PCB's in Target Group ÷ Required Number of Inspections.
[7]Source: Appendix A.
[8]Required Number of Plant Inspections = Required Probability of Inspection x Number of Plants.
[9]Source: Appendix A.

ADJUSTED REQUIRED NUMBER OF INSPECTION
TO INSURE THE PROPER DISPOSAL
OF ALL OF EACH TARGET GROUP'S PCB'S

INDUSTRY	TARGET GROUP	ADJUSTED REQUIRED NUMBER OF INSPECTIONS	
		TRANSFORMERS	CAPACITORS
UTILITY	Top 4 Companies	11	29
	Next 4 Companies	7	18
	Next 12 Companies	13	36
	Next 30 Companies	18	47
	Remaining Companies	29	77
AUTOMOBILES	Top 4 Companies	2	11
	Next 4 Companies	1	1
	Next 12 Companies	1	1
	Next 30 Companies	1	1
	Remaining Companies	3	1
FOOD	Top 4 Companies	21	4
	Next 4 Companies	11	2
	Next 12 Companies	14	2
	Next 30 Companies	20	2
	Remaining Companies	299	5
METALS	Top 4 Companies	12	36
	Next 4 Companies	4	10
	Next 12 Companies	8	11
	Next 30 Companies	10	7
	Remaining Companies	66	7
CHEMICALS	Top 4 Companies	14	24
	Next 4 Companies	7	10
	Next 12 Companies	8	14
	Next 30 Companies	13	10
	Remaining Companies	39	4

ADJUSTED REQUIRED NUMBER OF INSPECTION
TO INSURE THE PROPER DISPOSAL
OF ALL OF EACH TARGET GROUP'S PCB'S

		ADJUSTED REQUIRED NUMBER OF INSPECTIONS	
INDUSTRY	TARGET GROUP	TRANSFORMERS	CAPACITORS
TEXTILES	Top 4 Companies	8	3
	Next 4 Companies	5	1
	Next 12 Companies	9	2
	Next 30 Companies	14	2
	Remaining Companies	65	2
STONE, CLAY & GLASS	Top 4 Companies	10	6
	Next 4 Companies	5	2
	Next 12 Companies	7	2
	Next 30 Companies	9	1
	Remaining Companies	38	2
PAPER & LUMBER	Top 4 Companies	13	8
	Next 4 Companies	8	5
	Next 12 Companies	14	6
	Next 30 Companies	16	5
	Remaining Companies	264	8
MINING	Top 4 Companies	51	5
	Next 4 Companies	21	2
	Next 12 Companies	23	2
	Next 30 Companies	93	2
	Remaining Companies	—	—

RECOMMENDED INSPECTION SCHEDULE
UTILITIES AND INDUSTRIAL TARGET GROUPS

SECTOR OR INDUSTRY	TARGET GROUP	NUMBER OF JOINT INSPECTIONS	NUMBER OF TRANSFORMER INSPECTIONS
UTILITIES	Top 4 Companies (360)[1]	11	—
	Next 4 Companies (216)	7	—
	Next 12 Companies (446)	13	—
	Next 30 Companies (571)	18	—
	Remaining Companies (943)	29	—
	TOTAL	78	—
AUTOMOBILE	Top 4 Companies (58)	2	—
	Next 4 Companies (11)	1	—
	Next 12 Companies (17)	—	—
	Next 30 Companies (30)	—	—
	Remaining Companies (116)	—	—
	TOTAL	3	—
FOOD	Top 4 Companies (787)	4	23
	Next 4 Companies (393)	2	11
	Next 12 Companies (548)	2	16
	Next 30 Companies (759)	2	—
	Remaining Companies (11,562)	6	—
	TOTAL	16	50
METALS	Top 4 Companies (398)	12	—
	Next 4 Companies (137)	4	—
	Next 12 Companies (277)	8	—
	Next 30 Companies (327)	8	2
	Remaining Companies (2,201)	8	44
	TOTAL	40	46

[1]Numbers in parentheses indicate number of plants in target group.

RECOMMENDED INSPECTION SCHEDULE
UTILITIES AND INDUSTRIAL TARGET GROUPS
(continued)

SECTOR OR INDUSTRY	TARGET GROUP	NUMBER OF JOINT INSPECTIONS	NUMBER OF TRANSFORMER INSPECTIONS
TEXTILES	Top 4 Companies (236)	4	4
	Next 4 Companies (149)	2	3
	Next 12 Companies (249)	2	7
	Next 30 Companies (419)	2	12
	Remaining Companies (2,054)	2	—
	TOTAL	12	26
STONE, CLAY AND GLASS	Top 4 Companies (366)	6	4
	Next 4 Companies (169)	2	3
	Next 12 Companies (237)	2	5
	Next 30 Companies (316)	2	7
	Remaining Companies (1,404)	2	—
	TOTAL	14	19
PAPER AND LUMBER	Top 4 Companies (452)	10	3
	Next 4 Companies (316)	6	2
	Next 12 Companies (509)	8	6
	Next 30 Companies (588)	6	10
	Remaining Companies (9,436)	10	—
	TOTAL	40	21
MINING	Top 4 Companies (1,620)	6	—
	Next 4 Companies (660)	2	—
	Next 12 Companies (720)	2	—
	Next 30 Companies (3,000)	10	—
	Remaining Companies	—	—
	TOTAL	20	—

RECOMMENDED INSPECTION SCHEDULE
UTILITIES AND INDUSTRIAL TARGET GROUPS
(continued)

SECTOR OR INDUSTRY	TARGET GROUP	NUMBER OF JOINT INSPECTIONS	NUMBER OF TRANSFORMER INSPECTIONS
CHEMICALS	Top 4 Companies (495)	14	—
	Next 4 Companies (258)	7	—
	Next 12 Companies (311)	8	—
	Next 30 Companies (466)	12	1
	Remaining Companies (1,401)	4	35
	TOTAL	45	36

TOTAL NUMBER OF JOINT INSPECTIONS = 265

TOTAL NUMBER OF TRANSFORMER INSPECTIONS = 202

EQUIVALENT NUMBER OF JOINT INSPECTIONS IN PROGRAM = 398

This chapter outlines procedures for measuring the overall effectiveness of the PCB enforcement strategy, for interpreting these results in the light of the changed conditions or new information and, finally, for altering the enforcement strategy in response to these new conditions or information. These updating procedures rely on data collected by EPA inspectors during the inpection process and on new economic data which may become available to the EPA staff in the Office of Enforcement, as well as on changes in the PCB regulations which may arise. The sources and types of data likely to become available are discussed in the last section of this chapter.

MEASURING OVERALL EFFECTIVENESS

As discussed above, the objective of the enforcement strategy is to maximize the quantity of PCB's that are disposed of properly. Given this objective and based on a number of assumptions, PEB has recommended an enforcement strategy. As a first step in the updating procedure, it is important to assess whether or not the strategy implemented by the Office of Enforcement has met the objective.[1]

[1]The updating procedure assumes that the objective of maximizing the amount of PCB's disposed of properly is an appropriate objective. After the initial implementation of the enforcement strategy, EPA should assess the soundness of this objective. To assess the soundness of the underlying objective, EPA should review the number and type of violations detected by inspectors. This review, together with discussions with EPA inspectors, should enable the Office of Enforcement to judge the appropriateness of the objective of the enforcement program. For example, if review of this information revealed that more PCB's entered the environment through spills rather than improper disposal, the EPA should restate the aim of its enforcement strategy and redirect its efforts to ensure proper maintenance of PCB equipment while in service.

Two measures of effectiveness are recommended. The first is a measure of overall effectiveness of the enforcement strategy for each industry and sector. The second is measure of the specific level of effectiveness observed within each target group. The methodology for calculating each of these measures is given below.

Measure of Overall Effectiveness

The overall effectiveness of the enforcement strategy within each industry and sector can be measured by computing the percentage of the PCB's removed from service which were disposed of properly over the past year.[1] To measure this percentage, the quantity of PCB's disposed of properly should be divided by an estimate of the total amount of PCB's removed from service. The following methodology can be used to measure the overall effectiveness of the enforcement strategy for each industry or sector:

> STEP 1: Recompute the PCB's removed from service in each industry and sector over the past year using the inspection results on the number of transformers and capacitors in service, the age distribution of the remaining transformers and capacitors, and the computer model discussed in Chapter II which projects the PCB's removed from service each year.
>
> STEP 2: Calculate the PCB's disposed of in CWLF's and incinerators by each industry and sector over the past year using data from the RCRA manifest reporting system.[2]

---

[1] For the purposes of discussing the updating procedure, it is assumed that the enforcement strategy is updated annually. However, the strategy should actually be updated when new information necessitates substantial changes in the underlying assumptions.

[2] Prior to the startup of the RCRA system, record inspections will be the source of this information.

STEP 3: Divide the PCB's disposed of in CWLF's or incinerators by the projected amount of PCB's removed from service for a measure of overall effectiveness for each industry and sector.

These three steps yield the percent of PCB's removed from service which were disposed of properly over the past year as a measure of the overall effectiveness of the enforcement program.[1]

Measures of Effectiveness by Target Group

The effectiveness of the enforcement program within each target group can also be measured from the inspection results. To measure this effectiveness the number of transformer violations of all types detected should be divided by the number of transformers inspected. For capacitors, the number of capacitor violations of all types detected should be divided by the number of plants inspected.[2] Subtracting these effectiveness measures from 1.0 will yield the portion of the transformers inspected which are in compliance and the portion of the plants inspected which are in compliance with the PCB capacitor regulations.[3]

---

[1]Since the amount of PCB's disposed of in landfills and incinerators is an actual reported figure and the PCB's removed from service is a projection, the overall effectiveness measure may indicate that more than 100 percent of the PCB's removed from service were disposed of properly. Should this occur the assumptions underlying the removal from service projections should be reexamined. For example, a measure which exceeds 100 percent may indicate premature disposal of PCB equipment; that is, equipment disposed of before it fails or reaches the end of its service life.

[2]Recall that the compliance decision is assumed to be made at the individual transformer level for transformers but at the plant level for capacitors.

[3]Care must be taken to insure that multiple violations related to one transformer or one plant in the case of capacitors are treated as one transformer or plant not in compliance. This will prevent double counting of instances of noncompliance.

The recommended number of inspections to be performed in some target groups is very small. The estimates of effectiveness may, therefore, be inaccurate due to small sample size. Appendix F explains how confidence intervals can be established for these effectiveness measures.

Interpreting the Measures of Effectiveness

After calculating the measures of effectiveness for each sector or industry and for each target group and before revising the enforcement strategy, the difference between the actual effectiveness and the expected effectiveness should be explained.[1] For example, if a target group was inspected up to its required rate of inspection, the EPA would expect to find 100 percent of the plants in compliance. If the measure of effectiveness based on the number of violations detected revealed only a 65 percent compliance level, the source of this difference should be identified.

The difference between the expected and actual effectiveness can be divided into two variances:

1. The variance due to changing economic conditions, and
2. The variance due to the noneconomic factors considered in the decision to comply.

[1]Either measure of actual effectiveness — the overall or target group — can be used when interpreting the difference between actual and expected effectiveness. The measure selected should be based on the perceived quality of the data and on data availability.

Each of these variances between the expected and actual is discussed below.

VARIANCE 1: Economics of Compliance Decision

The economics of the compliance decision may have changed due to revised estimates of the distribution and average age of PCB equipment, new estimates of the cost of compliance and actual amounts of the assessed penalties. Changes in these three factors will alter the economic tradeoff of compliance versus noncompliance. This, in turn, will alter the required probability of inspection.

The distribution and average age of PCB equipment developed for this initial strategy are based on extremely limited data. Therefore, as additional information becomes available through inspections, these data should be used to modify the initial distribution by replacing the original estimate of the number of transformers per plant and the number of capacitors per plant with the average number found in the inspected plants. The original estimate of the average age of this PCB equipment should be replaced with the average age observed in the inspected plants.[1]

The cost of compliance will also change as incinerators are granted permits and as CWLF's are permitted to store these hazardous materials. In addition, EPA may have actual data on the

[1]For some target groups, these new estimates may be based on only one or two plants. Even though the sample sizes are small, these data are still preferable to estimates based on no empirical data. Appendix F discusses the calculation of confidence intervals for these estimates.

average amount of the assessed penalty per violation. This information will alter the economic tradeoff of compliance versus noncompliance. Therefore, the inspection effectiveness level for a given target group may be lower or higher than anticipated due to the altered economic conditions.

To calculate the difference between predicted and actual effectiveness due to the change in economic factors, the required probability of inspection should be recalculated for each target group for both transformers and capacitors. This calculation should use the new data on cost of compliance and penalty amounts, as well as the new distribution of transformers and capacitors per plant. The ratio of the actual inspection probability to the new required probability of inspection[1] is the expected level of compliance based on the new economic information. For example, assume 3 percent of the plants were inspected. If using the new economic data, the required probability of inspection should have been 4 percent, the level of compliance expected would be 75 percent (3 percent divided by 4 percent). The change in economic factors, therefore, accounts for 25 percentage points of the difference between the actual and expected levels of compliance within a target group.

VARIANCE 2: Accounting for Noneconomic Factors

After calculating the first variance, any residual variance is assumed to be the result of estimation error in the noneconomic factors which influence decision makers. The difference between the expected level of compliance calculated with revised economic data and the actual level of compliance is the second variance -- the variance between actual and expected

[1]To insure the proper disposal of all of a target group's PCB's.

levels of compliance not accounted for by economic factors. For example, if the new required risk of inspection was 4 percent, a 75 percent level of compliance would be expected at an actual inspection rate of 3 percent (3 percent divided by 4 percent). If the actual compliance level was 65 percent, the remaining 10 percentage point variance (75-65 percent) is assumed to result from inappropriately accounting for the noneconomic factors which influence the decision to comply.

This variance could arise if the target group's communication network or their awareness of the PCB problem was overestimated or underestimated. Also this variance could result from over or underestimating the importance of these noneconomic factors.

UPDATING THE ENFORCEMENT STRATEGY

The procedures described below are designed to enable the EPA to update the enforcement strategy to account for new information and changing economic conditions. The information gathered by the inspectors and available to EPA from other sources should be used to modify both the awareness and the inspection component of the enforcement strategy. Again, the objective of the enforcement strategy is to maximize the amount of PCB's disposed of properly.

Updating the Awareness Component

The awareness component has two parts. The first part is aimed at achieving a baseline level of awareness in all industries and sectors regarding the PCB regulations, the actions

PCB equipment user must take to comply with the regulation and sanctions available to the EPA in the case of noncompliance. e aim of the second part is to support the enforcement effort. modify the awareness component of the enforcement program, EPA ould review the measures of effectiveness for each target group, dustry and sector. The variances discussed above should also be viewed. New awareness efforts should be concentrated on those rget groups where the noneconomic variance accounts for a large rt of the difference in actual versus expected effectiveness.[1]

In addition, the EPA should review the number and type detected violations in each industry or sector and draw out the spectors' judgement concerning the level of awareness which ists within the different industries and sectors. Based on this formation, EPA should redirect some of the awareness resources ward industries and sectors where a large number of violations curred, particularly where it appears that these violations were result of ignorance. Some resources should also be directed ward industries or sectors where awareness is judged to be poor en though few violations have been detected.

Updating the Inspection Component

The inspection component of the enforcement strategy is esigned to create a perceived risk of inspection which will qualize the economic cost of compliance and the economic cost of

---

These awareness efforts should concentrate on informing firms bout the economic factors which should impact their decision to omply including the cost of compliance and the possible penalties or noncompliance.

noncompliance. Due to EPA's limited inspection resources, it is not possible to inspect each target group at the required rate of inspection. Thus the inspection resources were allocated to maximize the number of pounds of PCB's properly disposed. To do this, the inspection resources were allocated to target groups based on the average number of PCB transformers and capacitors per plant, the required rate of inspection to insure compliance in the target group, and the cost of an inspection.[1] As new data become available, each of these inputs should be updated to reflect the current data and the inspection resources should be reallocated.

To update the inspection procedure, the required risk of inspection must be recalculated based on the new estimates of the distribution of PCB equipment, new estimates on the cost of compliance and actual data on the penalty amounts assessed. This required risk of inspection is then adjusted as before for noneconomic factors. Finally, this adjusted required risk of inspection is readjusted again to account for the second variance (the variance between expected and actual levels of compliance due to estimation error in the noneconomic factors). Using these final adjusted required risks of inspection, new inspection efficiencies are calculated and the computer model is rerun to reallocate inspection resources to target groups.

[1]As discussed in Chapter IV, two types of inspections were considered — a transformer inspection and a joint inspection. It was estimated that the cost of a joint inspection would be 150 percent of the cost of a transformer inspection.

The following procedure can be used to update the inspection component of the enforcement strategy.

STEP 1: Recompute the average number of transformers and capacitors per plant in each target group using the data gathered in the inspections.

STEP 2: Using the new estimates of cost of compliance and the average amount of the penalties actually assessed, recompute the required risk of inspection necessary to make the target group members economically prefer compliance with the PCB disposal regulations.[1]

STEP 3: Adjust the required risk of inspection for each target group for the noneconomic factors as was done in the initial strategy.[2]

STEP 4: Compute the variance between expected versus actual effectiveness due to estimation error in the noneconomic factors.[3]

---

[1]See Appendix C for a detailed explanation of the calculation of this required risk of inspection.

[2]See Appendix D.

[3]As explained previously, to compute this variance:

- Compare this new adjusted required risk of inspection to the actual inspection rate. Project the expected effectiveness of inspections for each target group by dividing the actual rate of inspection by the adjusted required risk calculated in Step 3.

- Subtract the actual measure of effectiveness from the expected effectiveness of inspections. This difference represents the variance due to improper adjustment for noneconomic factors.

STEP 5: If the variance due to noneconomic factors is relatively small, adjust the required risk of inspection by multiplying this risk by one plus the variance.[1]

STEP 6: Recompute inspection efficiencies using the new adjusted required risks of inspection and the revised estimates of the number of transformers and capacitors per plant for each target group.[2]

STEP 7: Run the computer model to reallocate the available inspection resources given the new inspection efficiencies and the relative costs of joint and transformer inspections.[3]

Steps 1 through 3, 6, and 7 involve updating calculations already performed to arrive at the recommended inspection component and are described in the previous chapters and the Appendices. Steps 4 and 5, however, are unique to the updating procedure and an example will help clarify these steps.

Assume that recomputing the adjusted required risk of inspection given the new cost of compliance and assessed penalties yields an adjusted required risk of inspection of 4 percent. If the target group's actual rate of inspection was 3 percent, EPA would expect their inspections to be 75 percent effective (3 percent divided by 4 percent); that is, 75 percent of the PCB's

---

[1]If the expected effectiveness of the inspections is not relatively close to the industry or sector's measure of overall effectiveness, the assumptions concerning the economic and/or noneconomic factors affecting the decision to comply may be inaccurate. Discussions with inspectors and industry representatives should be held to determine the accuracy of these assumptions.

[2]See Appendix D.

[3]See Appendix E for a description of this computer model.

removed from service in this target group were disposed of properly. If the measure of actual effectiveness discussed above was 65 percent for this target group, they did not perform as well as expected. The variance due to improperly accounting for noneconomic factors is, therefore, 10 percent.

To alter the adjusted required risk of inspection the risk is multiplied by one plus the variance. Thus, the new required risk of inspection is 4.4 percent (4 percent multiplied by 1.10). This rate is then used to recalculate inspection efficiencies as discussed in Chapter IV and Appendix D.

While this adjustment is reasonable if the variance due to noneconomic factors is small, it should not be used if the expected and actual effectiveness measures are very different. If the measures differ significantly, the assumptions underlying the computation of required inspection rates should be investigated.

INFORMATION FOR UPDATING
THE ENFORCEMENT STRATEGY

Updating the enforcement strategy requries that new information be gathered from inspections and other sources. The new information likely to be available to EPA can be categorized as follows:

1. Updated economic information on the cost of compliance, the amount of the penalties assessed for noncompliance and the available EPA resources. This information is gathered by EPA and based on changes in current conditions such as the permitting of an incinerator, alterations in the penalty policy, and changes in the Office of Enforcement's budget for PCB enforcement.

2. PCB quantity data gathered in the field. This information comes from the EPA inspection program and the RCRA manifest reporting system which requires all chemical waste landfills (CWLF's), incinerators and waste handlers to report on the hazardous wastes transported, treated or disposed each year.

The first category of information will enable EPA to reassess the economic tradeoffs of compliance versus noncompliance. The second category of information will allow EPA to set up a tracking system for PCB transformers and capacitors and to better estimate the amount of PCB equipment in each sector and industry, as well as when this equipment is likely to be retired. Together this information can be used to measure the overall effectiveness of the enforcement strategy and to modify the strategy.

The data which should be gathered during an inspection and the data available from the manifest reporting system are described below. Exhibit V-1 details the data required to update the enforcement strategy, the source of the data and the Office or personnel who should be responsible for collecting this data.

Inspection Data

The EPA inspector is in the unique position of being able to physically verify the existing equipment in the plant. Since the allocation of inspection resources relies heavily on an estimate of the number of transformers and capacitors in each target group's plants, it would be desirable to update these estimates. The inspector also may be able to infer from the plant's records or from physical inspection of a sample of the PCB equipment, the age of the PCB equipment and hence, the likely date of the equipment's removal from service. The inspector will also keep a record of the number and type of violations detected at each plant. Therefore, at a minimum, the inspector should gather the following information:

- the number of PCB transformers and capacitors in service in each plant,
- the age of each transformer and capacitor in the plant,[1] and
- the number and type of violations detected.

As discussed above, the inspectors' views of the plant manager's awareness of the PCB regulations and other qualitative data are also useful when updating the enforcement strategy.

Manifest Reporting System

The manifest reporting system will require all generators, transporters and disposers of hazardous waste to report on the amount, type and source of hazardous waste handled each year. This system is designed to track all hazardous wastes and hence, to detect violations by checking for discrepancies in the data. This system will allow EPA to keep a record of all PCB's disposed of properly in CWLF's or incinerators by each target group.

[1]The law does not require that age be reported. If these data are unavailable, the inspector should estimate the age distribution of the transformers and capacitors in the plant or, at a minimum, the average age of all PCB transformers and the average age of all PCB capacitors in the plant.

INFORMATION FOR UPDATING THE ENFORCEMENT STRATEGY

INFORMATION	SOURCE	OFFICE/PERSONNEL RESPONSIBLE FOR COLLECTING INFORMATION
Average number of PCB transformers and capacitors per plant	Inspections	EPA Inspectors
Age distribution of PCB equipment	Inspections	EPA Inspectors
Number and type of violations	Inspections	EPA Inspectors
PCB's disposed of properly	RCRA Manifest Reporting System[1]	Office of Hazardous Wastes
Cost of compliance	Estimates by EPA or EPA Contractors	Office of Enforcement
Cost of inspections	Office of Enforcement	Office of Enforcement
Amount of penalties assessed	Office of Enforcement	Office of Enforcement
EPA resources	Office of Enforcement	Office of Enforcement

[1] Inspections will be the source of this information prior to the startup of the RCRA system.